PHASE III: Full Scale Development

Step 16 Conduct HF/S system design review

Objective: To define requirements associated with an HF/S design review. Design reviews are necessary to assess the risk of design, and that the steps leading to these reviews are as follows:

- design policy
- design requirements
- system/subsystem architecture
- preliminary schematics/layout
- software preliminary design
- preliminary physical design
- software detailed design
- ***Preliminary Design Review (PDR)***
- design rules and guidelines
- software code inspections
- physical design vs requirements
- analyses (functional, thermal, reliability, etc.)
- product drawings and associated lists
- testing (software module, integration, system)
- installation and field manuals
- ***Critical Design Review (CDR)***

Inputs: results from all previous analyses

Outputs: results of HF/S design reviews

16.1 Evaluate the HF/S Program Plan for:

- completeness
- accuracy
- feasibility
- quality
- consistency
- compliance
- timeliness

16.1.1 evaluate the plan for completeness:

- determine that the plan include subplans for:
  - HF/S
  - safety and health hazard avoidance

        - man-machine integration test and evaluation
    - determine that the plan includes:
        - schedule and milestones
        - man-loading estimates
        - descriptions of the experience levels of assigned personnel
        - facility and equipment requirements
        - additional resources required
        - program funding requirements

16.1.2 evaluate the plan for accuracy

- determine that subplans are accurate

16.1.3 evaluate the plan for feasibility

- determine that schedules and workload estimates are realistic
- determine that resource requirements are realistic
- determine that funding requirements are feasible

16.1.4 evaluate the quality of the plan:

- does the plan identifies interfaces between the HF/S program and the engineering design program
- determine that the plan identifies points in the schedule where program products will be formally reviewed
- determine that the plan identifies constraints placed on the HF/S program
- determine that the plan identifies potential problem areas and proposed methods of resolution
- determine that the plan identifies program products as they are developed within the schedule
- determine that procedures for monitoring the HF/S efforts are clearly stated
- determine that procedures for quality assurance of HF/S efforts are clearly defined

16.1.5 evaluate the plan for consistency:

- determine that the elements of the overall plan are consistent, coordinated, and interactive
- determine that requirements associated with each element are compatible with requirements associated with others
- determine that schedules are consistent across elements
- determine that resource requirements are consistent
- determine design for operability requirements are consistent with the requirements for design for maintainability for the same equipment

16.1.6 evaluate the plan for compliance:

- determine - elements of the plan are in compliance with CG, industry, and international standards and guidelines

- determine that criteria are in compliance with CG, industry, and international standards and guidelines

16.1.7 evaluate the plan for timeliness:

- determine that HF/S program products will be produced in time to have an impact on system design
- determine sufficient time has been allocated for design reviews and test and evaluation exercises
- determine scheduling of HF/S activities parallels the events and activities of the engineering design effort

16.2 Evaluate the Life Support Plan for:

- completeness
- accuracy
- feasibility
- quality

16.2.1 evaluate the life support plan for completeness

- determine that the plan includes procedures & requirements for the design for safety
- determine that the plan includes procedures &requirements for the design for habitability
- determine that the plan includes procedures & requirements for the design of environmental factors and controls
- determine that the plan includes procedures & requirements for the design, location and operation of emergency equipment
- determine that the plan includes procedures & requirements for the design, location and operation or protective clothing
- determine - plan includes schedules & resource requirements

16.2.2 evaluate the life support plan for accuracy:

- determine that procedures and requirements are accurate
- determine that reference standards and data are current

16.2.3 evaluate the life support plan for feasibility:

- determine that schedules and manloading estimates are realistic

16.2.4 evaluate the life support plan for quality:

- determine that tasks to be performed are identified
- determine that criteria are provided to evaluate each task
- determine that the description of each task is sufficient to enable evaluation of the probable success of the plan
- determine that problems anticipated in performance of the plan are identified

16.3 Evaluate the Human-Machine Integration Test and Evaluation Plan for:

- completeness
- accuracy
- feasibility
- quality

16.3.1 evaluate the T&E plan for completeness

- assess the evaluation of equipment operability
- assess the evaluation of control/display arrangements
- assess the evaluation of panel arrangements
- assess the evaluation of workspace layout
- assess the evaluation of procedures and documentation
- assess the evaluation of man-computer interfaces
- assess the evaluation of information flow
- assess the evaluation of communications
- assess the evaluation of facility design
- assess the evaluation of coding concepts
- assess the evaluation of labeling and marking
- assess the evaluation of control/controller design
- assess the evaluation of display design
- assess the evaluation of displayed information design
- assess the evaluation of alarms and annunciators
- assess the evaluation of equipment/facility design for maintainability
    - component accessibility
    - equipment arrangements
    - component handling/transfer
    - component identification
    - test point location
    - maintenance procedures
    - diagnostics
    - maintenance displays
    - tools location
- assess the evaluation of equipment design for habitability
    - free volume
    - traffic patterns
    - furnishings
    - environmental factors
        - air quality/ventilation
        - temperature/humidity
        - lighting
        - noise
        - vibration
        - terrain
        - sea spray
        - weather
- assess the evaluation of equipment design for safety

        - hazard potential
            - electric shock
            - contact with moving parts
            - burns
            - blast, explosion
            - sharp edges or protrusions
            - trips or slips
            - radiation
            - steam
            - toxic materials
            - extreme environments
        - countermeasures
            - protective clothing
            - emergency equipment
            - alarms
            - emergency procedures
    - assess the evaluation of human/team performance
        - human performance effectiveness
        - human performance reliability
        - human productivity
        - workloads
        - information transfer
            - information quality
            - information accuracy
            - information timeliness
    - determine that the plan describes procedures and requirements for identifying test methods
        - equipment design evaluations
            - inspection
            - measurement
            - sampling
        - human performance evaluations
            - simulation
            - walkthrough
            - observation
            - interview
            - special tests
    - determine that the plan describes procedures and requirements for identifying test measures
    - determine that the plan describes procedures and requirements for identifying test criteria
        - CG, industry, and international standards and guidelines
        - performance criteria by tasks
        - information quality standards
        - speech intelligibility criteria
    - determine that the plan describes procedures and requirements for identifying data acquisition and recording techniques
    - determine that the plan describes procedures and requirements for identifying data

analysis techniques
- determine that the plan describes test schedules
- determine that the plan describes resource requirements
- determine that the plan describes workload estimates

16.3.2 evaluate the T&E plan for accuracy:

- determine that procedures and requirements are compatible with HF/S evaluation principles

16.3.3 evaluate the T&E plan for feasibility:

- determine that schedules and manloading estimates are realistic
- determine that resource requirements are feasible

16.3.4 evaluate the T&E plan for quality:

- determine that the interfaces with the TEMP are clearly identified
- determine that specific time periods are allotted for formal DT&E, OT&E, and design reviews
- determine that the scheduling of these time periods is adequate in terms of identifying problems early in the process
- determine that tasks to be performed are clearly identified
- determine that procedures are adequate for sampling system users, use conditions, and tasks to be evaluated
- determine that criteria are provided for evaluating each task
- determine that the description of each test and evaluation task is sufficient to enable evaluation of the probable success of the plan
- determine that problems are anticipated in performance of the plan

16.4 Evaluate the HF/S Evaluation of Similar Systems or Baseline Systems

16.4.1 identify the applicability of the evaluation

- verify areas evaluated on similar systems are directly applicable to the new system
- verify that criteria for including subsystem evaluation are stated

16.4.2 assess the completeness of the evaluation

- determine that the evaluation addresses the selection of areas to be evaluated
- determine that the evaluation addresses the basis for this selection
- determine that the evaluation addresses the selection of tasks
- determine the evaluation addresses the selection of equipment to be evaluated
- determine the evaluation addresses the selection of test conditions
- determine the evaluation addresses the selection of personnel
- determine the evaluation includes descriptions of test measures
- determine that the evaluation includes descriptions of test methods
- determine that the evaluation includes descriptions of test controls

- determine that the evaluation includes descriptions of test materials
- determine that the evaluation includes descriptions of instrumentation
- determine the evaluation includes descriptions of data recording equipment
- determine the evaluation includes descriptions of data analysis

16.4.3 assess the accuracy of the evaluation

- determine statistical analyses are correct and are appropriately applied

16.4.4 assess the quality of the evaluation

- determine if there are problems with test data reliability
- determine if there are problems with test data validity
- determine if HF/S problems are clearly identified
- determine if problems are prioritized
- determine if causes and contributing factors for serious HF/S problems are identified
- determine if conclusions are warranted by data

16.5 Evaluate HF/S Front-End Analysis for:

- completeness
- appropriateness
- consistency
- quality

16.5.1 evaluate front-end analyses for completeness

- determine that the analysis contains the results of mission analyses
- determine the analysis contains the results of functional analyses
- determine that the analysis contains the results of system requirements analysis
- determine that the analysis contains the results of functional allocation
- determine that the analysis contains position descriptions
- determine the analysis contains the results of task requirements analysis
- determine that the analysis contains the results of operational sequence analysis

16.5.2 evaluate front-end analyses for appropriateness:

- determine that the analysis is consistent with engineering analyses
- determine that the analysis is at level of detail appropriate for the expected complexity of human-machine interfaces

16.5.3 evaluate front-end analyses for consistency:

- determine that the analytic procedures, techniques and steps are consistent with accepted HF/S practice
- determine that the data generated in these analyses are consistent

16.5.4 evaluate front-end analyses for quality:

- verify that mission conditions were selected to ensure attention to HF/S requirements
- verify that functional analyses are based on mission requirements and constraints and not on design directions or concepts
- verify that system requirements reflect what the system must be capable of doing in order to perform each function
- verify system requirements are based on mission requirements and functional requirements, and not on preconceived design concepts
- verify that criteria for functional allocations are clearly stated
- verify that capabilities and limitations of people versus machines addressed in the functional allocations
- verify that functional allocations are consistent across systems and operating conditions
- verify that position descriptions are based on functions allocated to the position
- verify that position descriptions include duties, jobs, responsibilities, levels of authority, tasks and decisions appropriate for each position
- verify assignment of duties and tasks to each position is realistic
- verify duties and jobs are consistent with those found in existing systems
- verify that task sequences by position are complete
- verify that task requirements are complete
- verify task requirements analyses includes information needed to complete the task
- verify that task requirements analyses includes control authority needed to complete the task
- verify that task requirements analyses includes decisions needed to complete the task
- verify that task requirements analyses includes estimates of task duration and frequency
- verify that task requirements analyses includes types of efforts expected with the task
- verify that task requirements analyses includes indications of the impact of errors
- verify that task requirements analyses includes special skills/knowledge required for performance of each task
- verify that operational sequence diagrams depict type of links, and link frequency and duration

16.6 Evaluate the Role-of-Man (Versus Automation) in the System

16.6.1 evaluate the analysis for completeness

- verify that each system function is allocated to human or machine performance
- verify that the role of the machine in manual tasks is defined
- verify that the role-of-man in automated tasks is defined

16.6.2 evaluate the analysis for quality:

- determine that tradeoff criteria for selected human versus machine performance are clearly stated
- determine that the tradeoff procedure is documented
- determine that it is stated how the man will monitor automated processes
- determine how he will intervene and take over from the machine in event of failures
- determine if the analysis makes it clear if the man or machine will perform information

acquisition
- determine if the analysis makes it clear if the man or machine will perform information update/entry
- determine if the analysis makes it clear if the man or machine will perform information processing
- determine if the analysis makes it clear if the man or machine will perform information quality check
- determine if the analysis makes it clear if the man or machine will perform information dissemination
- determine if the analysis makes it clear if the man or machine will perform decision formulation
- determine if the analysis makes it clear if the man or machine will perform decision making
- determine if the analysis makes it clear if the man or machine will perform selection of response
- determine if the analysis makes it clear if the man or machine will perform initiation of response
- determine if the analysis makes it clear if the man or machine will perform verification of response
- determine functional allocations are described for failure, backup, and contingency modes
- determine data obtained from evaluations of similar or baseline
- determine that operator workloads are realistic
- determine that machine loads are realistic

16.7 Evaluate HF/S Conceptual Design

16.7.1 evaluate the completeness of design concepts

- verify that tradeoff criteria are presented
- verify that the relationship of each concept to implementations in existing systems is described
- verify that concepts are presented for all man- machine interfaces

16.7.2 evaluate the accuracy of design concepts

- verify that selected designs satisfy system requirements
  the Human Engineering Progress Report (HEPR)
  - Does the HEPR describe progress and activity in sufficient detail to demonstrate that human engineering considerations are reflected in system analysis, design and development, and test and evaluation?
  - Does the HEPR describe status of all human engineering activity?
  - Does the HEPR describe human engineering design recommendations?
  - Does the HEPR describe human engineering participation in design reviews?
  - Does the HEPR describe summary results of human engineering analyses, studies, experiments, mock-up evaluations, simulations, tests, and demonstrations?
  - Does the HEPR describe projects requiring human engineering

- Does the HEPR describe deviations from the human engineering program plan?

16.7.3 Verify safety and supportability concepts

- verify selected concepts reflect concerns for biomedical effects, safety, and environmental effects
- verify that selected concepts reflect concerns for manning and skill levels of personnel
- verify that concepts for maintainability design are included

16.7.4 evaluate the timeliness of design concepts

- verify that concept reports are updated as concepts are modified

16.7.5 evaluate the completeness of design drawings

- verify that drawings are provided for all consoles, facilities, and other man-equipment interfaces
- verify that drawings are complete and annotated
- evaluate the accuracy of design drawing
- verify that drawings accurately reflect design concepts
- verify that drawing dimensions and quantities are accurate

16.7.6 evaluate the quality of design drawings

- verify designs depicted in drawings conform to CG, industry, and international standards and guidelines
- verify that drawings present three dimensional views of arrangements
- verify that workspace protrusions and obstructions are depicted in drawings
- verify that maintenance workspace and component accessibility are evident in facility drawings
- verify that drawings of computer terminal graphic displays are provided, in color where required
- verify that there is a formal HF/S sign- off of drawings

16.7.7 evaluate the timeliness of design drawings

- verify that drawings are dated?
- verify system is in place to ensure that HF/S specialists are provided with the most current drawings

16.7.8 evaluate the completeness of arrangement inputs

- verify that the HF/S program provides input to all arrangements that involve human habitation, translation, or workspace

16.7.9 evaluate the accuracy of arrangement inputs

16.7.10 verify that arrangement dimensions are based on expected user

anthropometry and clothing conditions

16.7.11 evaluate the quality of arrangement inputs

- verify that there is a HF/S sign-off to arrangement design
- verify that safety hazards are considered in arrangements
- verify that human performance is considered
- verify that biomedical/environmental factors are considered

16.7.12 evaluate the timeliness of arrangement inputs

16.8 Evaluate the HF/S Design of Consoles, Control Panels, Controls and Displays in terms of:

- performance effectiveness
- operability design
- maintainability design
- safety design
- environmental design

16.8.1 evaluate design in terms of performance effectiveness:

- verify that tasks associated with controls and displays have been identified
- verify operator performance capability has been demonstrated to meet performance requirements
- verify that designs are based on man-machine studies and walkthroughs
- verify that details of the design are consistent with CG, industry, and international standards and guidelines
- verify that error likelihood analyses have been performed to identify types of performance errors associated with the design approach
- verify that HF/S specialists have been delegated sign-off authority over console and panel designs
- verify that contractor proposal solicitations contain HFE design criteria
- verify that proposal evaluation criteria include HF/S concerns

16.8.2 evaluate design in terms of operability

- verify that operational procedures have been developed
- verify that control and display arrangements are based on sequence of use, priority and functional grouping
- verify that error likelihood analyses have been conducted to identify expected procedural errors

16.8.3 evaluate design in terms of maintainability

- verify that panels and consoles are designed to be maintainable

16.8.4 evaluate design for safety

- verify that warnings are provided for hazardous operations/maintenance actions

16.8.5 evaluate environmental design

- 16.8.5.1 verify that operator/maintainer anthropometry been applied to workspace design
- 16.8.5.2 verify that panels are operable when operators are wearing protective clothing
- 16.8.5.3 verify that environmental effects have been considered in the design

16.9 Evaluate HF/S Design of Communications

16.9.1 evaluate communications in terms of performance effectiveness

- verify that sufficient communication devices/systems have been provided for all communication requirements
- verify that communications system designs are based on link analyses and operational sequence analyses
- verify that design of each device is based on CG, industry, and international standards and guidelines

16.9.2 evaluate communications in terms of intelligibility

- verify that speech intelligibility evaluations have been conducted for devices used in similar systems
- verify that data from these evaluations have been considered in the design of devices
- verify that speech intelligibility evaluations for the new system have been conducted or are planned
- verify that message samples, noise conditions, and device fidelity are acceptable in terms of human engineering standards

16.9.3 evaluate communications in terms of message acceptability

- verify that messages are standardized
- verify that messages are based on constrained language, controlled syntax, and restricted

16.9.4 evaluate communications in terms of message content

- verify that message priority is coded
- verify that an error likelihood analysis was conducted to identify potential errors in message transmission

16.9.5 evaluate communications in terms of station characteristics

- verify that walkthroughs of communications traffic were used in identifying station characteristics
- verify that mobility requirements on the part of users were considered
- verify that user clothing conditions were considered

- verify that network requirements were based on link analysis
- verify that the range of potential environments (especially noise and vibration) were considered in design of stations

16.10 Evaluate HF/S Design of Facilities/Workspace

16.10.1 evaluate facility design in terms of performance effectiveness

- verify that facility designs and arrangements are based on what people must do in them
- verify that likely errors have been identified for each facility
- verify that traffic patterns have been identified
- verify that arrangements reflect traffic patterns
- verify that arrangements reflect cargo transfer requirements

16.10.2 evaluate facility design in terms of operability design

- verify that man-machine interface designs (hand holds, steps, passageways, etc.) comply with CG, industry, and international standards and guidelines

16.10.3 evaluate facility design in terms of maintainability design

- verify that arrangement designs include consideration of requirements for maintenance access
- verify that workspace for maintenance sufficient based on use anthropometrics

16.10.4 evaluate facility design in terms of safety design

- verify that emergency equipments (i.e., fire extinguishers) are readily accessible
- verify that protective clothing is readily accessible
- verify that safety hazards are shielded or guarded

16.10.5 evaluate facility design in terms of habitability design

- verify that environmental controls are included in facilities
- verify that environmental limits comply with CG, industry, and international standards and guidelines
- verify that provisions for environmental.protection have been included in the design
- verify that biomedical requirements and risk areas have been resolved

16.11 Evaluate HF/S Design Reviews for:

- completeness
- timeliness
- quality

16.11.1 evaluate design reviews for completeness:

- verify that all man-machine interfaces were included
- verify that the rationale for not including all interfaces was presented
- verify that the rationale for selecting tasks for evaluation was presented

16.11.2 evaluate design reviews for timeliness:

- verify that design reviews data were obtained in time to impact final designs

16.11.3 evaluate design reviews for quality:

- verify that procedures were implemented for mockup development
- determine what formal tests were conducted
- determine what walkthroughs were conducted
- determine if there are any problems with design review data reliability and validity
- determine what evaluation procedures were used
- determine what data analysis was conducted
- determine what was the fidelity level of console mockups

16.12 Evaluate HF/S Development/Operational Test and Evaluation

16.12.1 Assess T&E in terms of completeness

- verify that test criteria are identified
- verify that test procedures are described
- verify that dependent measures are described

16.12.2 Assess T&E in terms of accuracy

- verify that the tests were conducted in accordance with the HF/S Test Evaluation practices

16.12.3 Assess T&E in terms of quality

- verify that HF/S problems are discussed in DT&E and OT&E reports
- verify that HF/S problems have been identified in DT-1 and OT-1 test reports
- verify that have human performance problems have been identified in DT-1 and/or OT-1 test reports and that solutions have been formulated
- verify that environmental effects problems have been identified in the DT-1 and/or DT-2 test reports and that solutions have been formulated
- verify that situations have been identified in DT- test reports where equipment design does not comply to HF/S standards and that solutions have been formulated
- verify that biomedical problems have been identified in DT-1 and/or OT-1 test reports and that solutions have been formulated
- verify that DT&E reports identified human performance problems
- verify that DT&E reports identified human safety problems
- verify that DT&E reports identified environmental problems
- verify that DT&E reports identified biomedical/life support problems
- verify that DT&E reports identified human productivity problems

- verify that DT&E reports identified HF/S problems
- verify that DT&E reports identified information transfer problems
- verify that steps to resolve these problems have been identified
- verify that OT&E reports identified problems for operator performance
- verify that OT&E reports identified problems for team performance
- verify that OT&E reports identified problems for workload
- verify that OT&E reports identified problems for productivity
- verify that OT&E reports identified problems for maintenance performance
- verify that OT&E reports identified problems for system organization
- verify that OT&E reports identified problems for information transfer
- verify that OT&E reports identified problems for manning level
- verify that OT&E reports identified problems for skill level
- verify that OT&E reports identified problems for training
- verify that OT&E reports identified problems for training system
- verify that steps to resolve these problems have been identified

16.13 Evaluate System Procedures and Documentation for:

- completeness
- accuracy
- clarity
- consistency
- compatibility
- accessibility
- usability
- readability
- updateability

16.13.1 evaluate procedures/documentation for completeness

- verify that text is complete
- verify that all relevant and appropriate topics have been addressed

16.13.2 evaluate procedures/documentation for accuracy

- verify that the text is accurate

16.13.3 evaluate procedures/documentation for clarity

- verify that the writing style is clear and concise
- verify that the document is indexed
- verify that illustrations are of sufficient quality

16.13.4 evaluate procedures/documentation for consistency

- verify that different documents are consistent concerning nomenclature, format, layout, and organization
- verify that nomenclature and jargon consistent within each document?

16.13.5 evaluate procedures/documentation for compatibility

- verify that the language level is compatible with reading skill levels of users

16.13.6 evaluate procedures/documentation for accessibility

- verify that the document is coded as to the subject, volume, or other descriptor
- verify that the document is readily accessible by users

16.13.7 evaluate procedures/documentation for usability

- verify that the document can be used in the use environment
- verify that sections and subsections can be readily accessed
- verify that illustrations and descriptive text appear at the same time, on the same page or on facing pages

16.13.8 evaluate procedures/documentation for readability

- verify that font style and size are such to make the text readily readable
- verify that character/page contract is such that the document is readable

16.13.9 evaluate procedures/documentation for updateability

- verify that the document can be easily modified or updated

16.14 Evaluate HF/S Criteria and Specifications for:

- completeness
- accuracy
- consistency
- quality

16.14.1 evaluate criteria and specifications for completeness

- verify that all man-machine interfaces are addressed
- verify that human performance, human reliability, and human error data been developed for input to human-machine interface design
- verify that HF/S standards and design criteria been applied to the design, development or selection of controls
- verify that HF/S standards and design criteria been applied to the design, development or selection of displays
- verify that HF/S standards and design criteria been applied to the design, development or selection of labels
- verify that HF/S standards and design criteria been applied to the design, development or selection of computer interfaces
- verify that HF/S standards and design criteria been applied to the design, development or selection of communications devices
- verify that HF/S standards and design criteria been applied to the design, development

or selection of control panels
- verify that HF/S standards and design criteria been applied to the design, development or selection of equipment design and arrangement for access
- verify that HF/S standards and design criteria been applied to the design, development or selection of equipment design for maintenance
- verify that HF/S standards and design criteria been applied to the design, development or selection of control systems
- verify that HF/S standards and design criteria been applied to the design, development or selection of information systems
- verify that HF/S standards and design criteria been applied to the design, development or selection of surveillance systems
- verify that HF/S standards and design criteria been applied to the design, development or selection of equipment transport systems
- verify that HF/S standards and design criteria been applied to the design, development or selection of material handling systems
- verify that HF/S standards and design criteria been applied to the design, development or selection of office systems
- verify that HF/S standards and design criteria been applied to the design, development or selection of communications systems
- verify that HF/S standards and design criteria been applied to the design, development or selection of production systems
- verify that HF/S standards and design criteria been applied to the design, development or selection of process control systems
- verify that HF/S standards and design criteria been applied to the design, development or selection of support systems
- verify that HF/S standards and design criteria been applied to the design, development or selection of facilities and facility workspace
- verify that HF/S issues have been considered in the design for supportability
- verify that HF/S standards and design criteria have been applied to the design and development of technical manuals, procedures, and systems user documentation?
- verify that HF/S aspects of system packaging and transportation have been addressed
- verify that human performance standards for maintenance have been developed

16.14.2 evaluate criteria and specifications for accuracy

- verify that HF/S standards and criteria conform to CG, industry, and international standards and guidelines
- verify that standards and criteria are based on man-machine studies, walkthroughs, simulation, tests, or design reviews

16.14.3 evaluate criteria and specifications for consistency

- verify that standards are consistent for different equipment items

16.14.4 evaluate criteria and specifications for quality

- verify that HF/S criteria and specifications are directly usable